

## WHAT IS CLAIMED IS:

1. A method for determining noise in radiography comprising::

acquiring at least two images,  $i-1$  and  $i$ , of a same zone;

coding the acquired images into digital images that can be identified with matrices having horizontal by vertical dimensions equal to  $N \times M$ , each digital image being then formed by  $N.M$  dots, each dot of an image  $i$  being identifiable by its coordinates  $0 < x < N$ , and  $0 < y < M$ , this dot then being referred to as a dot  $P_i(x,y)$ , each dot  $P_i(x,y)$  then having a corresponding value  $v$  which is the result of the acquisition of the image, the value  $v$  having a dynamic range from  $V_{min}$  to  $V_{max}$ ;

dividing the dynamic range  $V_{max} - V_{min}$  into sub-groups defined by a lower limit  $B_i$  and an upper limit  $B_s$ , the sub-groups having a null intersection, the joining of the sub-groups covering the dynamic range  $V_{max} - V_{min}$ , a dot of an image  $i$  then belonging to a given sub-group when  $B_i \leq P_i(x,y) < B_s$ , where  $P_i(x,y)$  is the gray level of the pixel of the image  $i$  with coordinates  $(x,y)$ ;

computing, for at least one sub-group  $SG$ , of the mean standard deviation  $\sigma$  of the values  $P_i(x,y) - P_{i-1}(x,y)$ ;

discriminating the values  $P_i(x,y)$  of  $SG$  to keep only those values such that the criterion  $C : P_i(x,y) - P_{i-1}(x,y) < \mu(P_i(x,y) - P_{i-1}(x,y)) + k.\sigma$ , is met and thus, a sub-group  $SG'$  is obtained, where  $\mu$  is a mean value;

applying the same processing operations to the sub-group  $SG'$  as to the sub-group  $SG$  by iteration until a sub-group  $SG''$ , corresponding to an end-of-iteration criterion, is obtained;

performing iterative processing operations on all the sub-groups defined in the dynamic range  $V_{max} - V_{min}$  and thus, for each sub-group, a mean standard deviation, associated with an x-axis value  $v = (B_i + B_s)/2$ , is obtained; and

performing an operation of regression on the dots obtained at the previous step to determine the coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  of the noise function:  $\sigma(v) = \alpha.\sqrt{v} + \beta.v + \gamma$  defining the noise for a given value  $v$ .

2. The method according to claim 1 wherein, before the regression and after the discrimination, the method eliminates, for the remainder of the processing, the non-centered sub-groups, that is, the sub-groups such that the mean of the sub-group is greater than 1 times the mean standard deviation, 1 being preferably equal to 1.5.

3. The method according to claim 2 wherein the noise function is applied to the images  $i$  to reduce the noise in this image.

4. The method according to claim 1 wherein the noise function is applied to the images  $i$  to reduce the noise in this image.

5. The method according to claim 1 wherein  $k$  is a non-null number.

6. The method according to claim 2 wherein  $k$  is a non-null number.

7. The method according to claim 3 wherein  $k$  is a non-null number.

8. The method according to claim 1 wherein the end-of-iteration criterion is a number of iterations greater than 5.

9. The method according to claim 2 wherein the end-of-iteration criterion is a number of iterations greater than 5.

10. The method according to claim 3 wherein the end-of-iteration criterion is a number of iterations greater than 5.

11. The method according to claim 5 wherein the end-of-iteration criterion is a number of iterations greater than 5.

12. The method according to claim 1 wherein the end-of-iteration criterion is the fact that all the dots of SG' meet the criterion C.

13. The method according to claim 2 wherein the end-of-iteration criterion is the fact that all the dots of SG' meet the criterion C.

14. The method according to claim 3 wherein the end-of-iteration criterion is the fact that all the dots of SG' meet the criterion C.

15. The method according to claim 5 wherein the end-of-iteration criterion is the fact that all the dots of SG' meet the criterion C.

16. The method according to claim 8 wherein the end-of-iteration criterion is the fact that all the dots of SG' meet the criterion C.

17. The method according to claim 1 wherein:  
during a first regression, first coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  are obtained;  
determining a curve that separates the sub-groups into two, those whose mean standard deviation is above the first curve and those whose mean standard deviation is below the first curve;  
a weighting P of less than 1 is applied to the mean standard deviation of the sub-groups whose mean standard deviation is located above the first curve;  
a second regression is performed from the weighted sub-groups to obtain second coefficients  $\alpha'$ ,  $\beta'$  and  $\gamma'$  determining a new noise curve; and  
from the new curve, the same processing operations are carried out as those performed from the first curve, and so on and so forth, for a number of times equal to R.

18. The method according to claim 2 wherein:  
during a first regression, first coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  are obtained;  
determining a curve that separates the sub-groups into two, those whose mean standard deviation is above the first curve and those whose mean standard deviation is below the first curve;

a weighting  $P$  of less than 1 is applied to the mean standard deviation of the sub-groups whose mean standard deviation is located above the first curve;

a second regression is performed from the weighted sub-groups to obtain second coefficients  $\alpha'$ ,  $\beta'$  and  $\gamma'$  determining a new noise curve; and

from the new curve, the same processing operations are carried out as those performed from the first curve, and so on and so forth, for a number of times equal to  $R$ .

19. The method according to claim 3 wherein:

during a first regression, first coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  are obtained;

determining a curve that separates the sub-groups into two, those whose mean standard deviation is above the first curve and those whose mean standard deviation is below the first curve;

a weighting  $P$  of less than 1 is applied to the mean standard deviation of the sub-groups whose mean standard deviation is located above the first curve;

a second regression is performed from the weighted sub-groups to obtain second coefficients  $\alpha'$ ,  $\beta'$  and  $\gamma'$  determining a new noise curve; and

from the new curve, the same processing operations are carried out as those performed from the first curve, and so on and so forth, for a number of times equal to  $R$ .

20. The method according to claim 4 wherein:

during a first regression, first coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  are obtained;

determining a curve that separates the sub-groups into two, those whose mean standard deviation is above the first curve and those whose mean standard deviation is below the first curve;

a weighting  $P$  of less than 1 is applied to the mean standard deviation of the sub-groups whose mean standard deviation is located above the first curve;

a second regression is performed from the weighted sub-groups to obtain second coefficients  $\alpha'$ ,  $\beta'$  and  $\gamma'$  determining a new noise curve; and

from the new curve, the same processing operations are carried out as those performed from the first curve, and so on and so forth, for a number of times equal to R.

21. The method according to claim 8 wherein:

during a first regression, first coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  are obtained;

determining a curve that separates the sub-groups into two, those whose mean standard deviation is above the first curve and those whose mean standard deviation is below the first curve;

a weighting P of less than 1 is applied to the mean standard deviation of the sub-groups whose mean standard deviation is located above the first curve;

a second regression is performed from the weighted sub-groups to obtain second coefficients  $\alpha'$ ,  $\beta'$  and  $\gamma'$  determining a new noise curve; and

from the new curve, the same processing operations are carried out as those performed from the first curve, and so on and so forth, for a number of times equal to R.

22. The method according to claim 12 wherein:

during a first regression, first coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  are obtained;

determining a curve that separates the sub-groups into two, those whose mean standard deviation is above the first curve and those whose mean standard deviation is below the first curve;

a weighting P of less than 1 is applied to the mean standard deviation of the sub-groups whose mean standard deviation is located above the first curve;

a second regression is performed from the weighted sub-groups to obtain second coefficients  $\alpha'$ ,  $\beta'$  and  $\gamma'$  determining a new noise curve; and

from the new curve, the same processing operations are carried out as those performed from the first curve, and so on and so forth, for a number of times equal to R.

23. The method according to claim 17 wherein P is in the interval [0,75 ... 0,99].
24. The method according to claim 18 wherein P is in the interval [0,75 ... 0,99].
25. The method according to claim 19 wherein P is in the interval [0,75 ... 0,99].
26. The method according to claim 20 wherein P is in the interval [0,75 ... 0,99].
27. The method according to claim 21 wherein P is in the interval [0,75 ... 0,99].
28. The method according to claim 22 wherein P is in the interval [0,75 ... 0,99].
29. The method according to claim 23 wherein P is in the interval [0,75 ... 0,99].
30. The method according to claim 17 wherein P is in the interval [0 ... 0,75].
31. The method according to claim 18 wherein P is in the interval [0 ... 0,75].
32. The method according to claim 19 wherein P is in the interval [0 ... 0,75].
33. The method according to claim 20 wherein P is in the interval [0 ... 0,75].
34. The method according to claim 21 wherein P is in the interval [0 ... 0,75].

35. The method according to claim 22 wherein P is in the interval [0 ... 0,75].
36. The method according to claim 23 wherein P is in the interval [0 ... 0,75].
37. The method according to claim 17 wherein R is in the interval [3 ... 10].
38. The method according to claim 18 wherein R is in the interval [3 ... 10].
39. The method according to claim 19 wherein R is in the interval [3 ... 10].
40. The method according to claim 20 wherein R is in the interval [3 ... 10].
41. The method according to claim 21 wherein R is in the interval [3 ... 10].
42. The method according to claim 22 wherein R is in the interval [3 ... 10].
43. The method according to claim 23 wherein R is in the interval [3 ... 10].
44. The method according to claims 17 wherein R is greater than 10.
45. The method according to claims 18 wherein R is greater than 10.
46. The method according to claims 19 wherein R is greater than 10.
47. The method according to claims 20 wherein R is greater than 10.
48. The method according to claims 21 wherein R is greater than 10.
49. The method according to claims 22 wherein R is greater than 10.
50. The method according to claims 23 wherein R is greater than 10.

51. A computer program comprising program code means for implementing steps of a method, when the program runs on a computer, wherein the program code means comprises:

computer readable program code means for causing a computer to provide for acquiring at least two images,  $i-1$  and  $i$ , of a same zone;

computer readable program code means for causing a computer to provide for coding the acquired images into digital images that can be identified with matrices having horizontal by vertical dimensions equal to  $N \times M$ , each digital image being then formed by  $N.M$  dots, each dot of an image  $i$  being identifiable by its coordinates  $0 < x < N$ , and  $0 < y < M$ , this dot then being referred to as a dot  $P_i(x,y)$ , each dot  $P_i(x,y)$  then having a corresponding value  $v$  which is the result of the acquisition of the image, the value  $v$  having a dynamic range from  $V_{min}$  to  $V_{max}$ ;

computer readable program code means for causing a computer to provide for dividing the dynamic range  $V_{max} - V_{min}$  into sub-groups defined by a lower limit  $B_i$  and an upper limit  $B_s$ , the sub-groups having a null intersection, the joining of the sub-groups covering the dynamic range  $V_{max} - V_{min}$ , a dot of an image  $i$  then belonging to a given sub-group when  $B_i \leq P_i(x,y) < B_s$ , where  $P_i(x,y)$  is the gray level of the pixel of the image  $i$  with coordinates  $(x,y)$ ;

computer readable program code means for causing a computer to provide for computing, for at least one sub-group  $SG$ , of the mean standard deviation  $\sigma$  of the values  $P_i(x,y) - P_{i-1}(x,y)$ ;

computer readable program code means for causing a computer to provide for discriminating the values  $P_i(x,y)$  of  $SG$  to keep only those values such that the criterion  $C : P_i(x,y) - P_{i-1}(x,y) < \mu(P_i(x,y) - P_{i-1}(x,y)) + k.\sigma$ , is met and thus, a sub-group  $SG'$  is obtained, where  $\mu$  is a mean value;

computer readable program code means for causing a computer to provide for applying the same processing operations to the sub-group  $SG'$  as to the sub-group  $SG$  by iteration until a sub-group  $SG''$ , corresponding to an end-of-iteration criterion, is obtained;



computer readable program code means for causing a computer to provide for performing iterative processing operations on all the sub-groups defined in the dynamic range  $V_{\max} - V_{\min}$  and thus, for each sub-group, a mean standard deviation, associated with an x-axis value  $v = (B_i + B_s)/2$ , is obtained; and

computer readable program code means for causing a computer to provide for performing an operation of regression on the dots obtained at the previous step to determine the coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  of the noise function:  $\sigma(v) = \alpha \cdot \sqrt{v} + \beta \cdot v + \gamma$  defining the noise for a given value  $v$ .

52. A computer program product comprising a computer useable medium having computer readable program code means embodied in the medium, the computer readable program code means implementing steps of a method, wherein the computer readable program code means comprises:

computer readable program code means embodied in a medium for causing a computer to provide for acquiring at least two images,  $i-1$  and  $i$ , of a same zone;

computer readable program code means embodied in a medium for causing a computer to provide for coding the acquired images into digital images that can be identified with matrices having horizontal by vertical dimensions equal to  $N \times M$ , each digital image being then formed by  $N \cdot M$  dots, each dot of an image  $i$  being identifiable by its coordinates  $0 < x < N$ , and  $0 < y < M$ , this dot then being referred to as a dot  $P_i(x,y)$ , each dot  $P_i(x,y)$  then having a corresponding value  $v$  which is the result of the acquisition of the image, the value  $v$  having a dynamic range from  $V_{\min}$  to  $V_{\max}$ ;

computer readable program code means embodied in a medium for causing a computer to provide for dividing the dynamic range  $V_{\max} - V_{\min}$  into sub-groups defined by a lower limit  $B_i$  and an upper limit  $B_s$ , the sub-groups having a null intersection, the joining of the sub-groups covering the dynamic range  $V_{\max} - V_{\min}$ , a dot of an image  $i$  then belonging to a given sub-group when  $B_i \leq P_i(x,y) < B_s$ , where  $P_i(x,y)$  is the gray level of the pixel of the image  $i$  with coordinates  $(x,y)$ ;

computer readable program code means embodied in a medium for causing a computer to provide for computing, for at least one sub-group  $SG$ , of the mean standard deviation  $\sigma$  of the values  $P_i(x,y) - P_{i-1}(x,y)$ ;

computer readable program code means embodied in a medium for causing a computer to provide for discriminating the values  $P_i(x,y)$  of SG to keep only those values such that the criterion  $C : P_i(x,y) - P_{i-1}(x,y) < \mu(P_i(x,y) - P_{i-1}(x,y)) + k.\sigma$ , is met and thus, a sub-group SG' is obtained, where  $\mu$  is a mean value;

computer readable program code means embodied in a medium for causing a computer to provide for applying the same processing operations to the sub-group SG' as to the sub-group SG by iteration until a sub-group SG'', corresponding to an end-of-iteration criterion, is obtained;

computer readable program code means embodied in a medium for causing a computer to provide for performing iterative processing operations on all the sub-groups defined in the dynamic range  $V_{max} - V_{min}$  and thus, for each sub-group, a mean standard deviation, associated with an x-axis value  $v = (B_i + B_s)/2$ , is obtained; and

computer readable program code means embodied in a medium for causing a computer to provide for performing an operation of regression on the dots obtained at the previous step to determine the coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  of the noise function:  $\sigma(v) = \alpha.\sqrt{v} + \beta.v + \gamma$  defining the noise for a given value  $v$ .

53. An article of manufacture for use with a computer system, the article of manufacture comprising a computer readable medium having computer readable program code means embodied in the medium, the program code means implementing steps of a method, the program code means comprising:

computer readable program code means embodied in a medium for causing a computer to provide for acquiring at least two images,  $i-1$  and  $i$ , of a same zone;

computer readable program code means embodied in a medium for causing a computer to provide for coding the acquired images into digital images that can be identified with matrices having horizontal by vertical dimensions equal to  $N \times M$ , each digital image being then formed by  $N.M$  dots, each dot of an image  $i$  being identifiable by its coordinates  $0 < x < N$ , and  $0 < y < M$ , this dot then being referred to as a dot  $P_i(x,y)$ , each dot  $P_i(x,y)$  then having a corresponding value  $v$  which is the result of the acquisition of the image, the value  $v$  having a dynamic range from  $V_{min}$  to  $V_{max}$ ;

computer readable program code means embodied in a medium for causing a computer to provide for dividing the dynamic range  $V_{\max} - V_{\min}$  into sub-groups defined by a lower limit  $B_i$  and an upper limit  $B_s$ , the sub-groups having a null intersection, the joining of the sub-groups covering the dynamic range  $V_{\max} - V_{\min}$ , a dot of an image  $i$  then belonging to a given sub-group when  $B_i \leq P_i(x,y) < B_s$ , where  $P_i(x,y)$  is the gray level of the pixel of the image  $i$  with coordinates  $(x,y)$ ;

computer readable program code means embodied in a medium for causing a computer to provide for computing, for at least one sub-group  $SG$ , of the mean standard deviation  $\sigma$  of the values  $P_i(x,y) - P_{i-1}(x,y)$ ;

computer readable program code means embodied in a medium for causing a computer to provide for discriminating the values  $P_i(x,y)$  of  $SG$  to keep only those values such that the criterion  $C : P_i(x,y) - P_{i-1}(x,y) < \mu(P_i(x,y) - P_{i-1}(x,y)) + k.\sigma$ , is met and thus, a sub-group  $SG'$  is obtained, where  $\mu$  is a mean value;

computer readable program code means embodied in a medium for causing a computer to provide for applying the same processing operations to the sub-group  $SG'$  as to the sub-group  $SG$  by iteration until a sub-group  $SG''$ , corresponding to an end-of-iteration criterion, is obtained;

computer readable program code means embodied in a medium for causing a computer to provide for performing iterative processing operations on all the sub-groups defined in the dynamic range  $V_{\max} - V_{\min}$  and thus, for each sub-group, a mean standard deviation, associated with an x-axis value  $v = (B_i + B_s)/2$ , is obtained; and

computer readable program code means embodied in a medium for causing a computer to provide for performing an operation of regression on the dots obtained at the previous step to determine the coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  of the noise function:  $\sigma(v) = \alpha.\sqrt{v} + \beta.v + \gamma$  defining the noise for a given value  $v$ .

54. A program storage device readable by a machine tangibly embodying a program of instructions executable by the machine to perform steps of a method comprising:

the program of instructions embodied in a medium for causing the machine to provide for acquiring at least two images,  $i-1$  and  $i$ , of a same zone;

the program of instructions embodied in a medium for causing the machine to provide for coding the acquired images into digital images that can be identified with matrices having horizontal by vertical dimensions equal to  $N \times M$ , each digital image being then formed by  $N.M$  dots, each dot of an image  $i$  being identifiable by its coordinates  $0 < x < N$ , and  $0 < y < M$ , this dot then being referred to as a dot  $P_i(x,y)$ , each dot  $P_i(x,y)$  then having a corresponding value  $v$  which is the result of the acquisition of the image, the value  $v$  having a dynamic range from  $V_{min}$  to  $V_{max}$ ;

the program of instructions embodied in a medium for causing the machine to provide for dividing the dynamic range  $V_{max} - V_{min}$  into sub-groups defined by a lower limit  $B_i$  and an upper limit  $B_s$ , the sub-groups having a null intersection, the joining of the sub-groups covering the dynamic range  $V_{max} - V_{min}$ , a dot of an image  $i$  then belonging to a given sub-group when  $B_i \leq P_i(x,y) < B_s$ , where  $P_i(x,y)$  is the gray level of the pixel of the image  $i$  with coordinates  $(x,y)$ ;

the program of instructions embodied in a medium for causing the machine to provide for computing, for at least one sub-group  $SG$ , of the mean standard deviation  $\sigma$  of the values  $P_i(x,y) - P_{i-1}(x,y)$ ;

the program of instructions embodied in a medium for causing the machine to provide for discriminating the values  $P_i(x,y)$  of  $SG$  to keep only those values such that the criterion  $C : P_i(x,y) - P_{i-1}(x,y) < \mu(P_i(x,y) - P_{i-1}(x,y)) + k.\sigma$ , is met and thus, a sub-group  $SG'$  is obtained, where  $\mu$  is a mean value;

the program of instructions embodied in a medium for causing the machine to provide for applying the same processing operations to the sub-group  $SG'$  as to the sub-group  $SG$  by iteration until a sub-group  $SG''$ , corresponding to an end-of-iteration criterion, is obtained;

the program of instructions embodied in a medium for causing the machine to provide for performing iterative processing operations on all the sub-groups defined in the dynamic range  $V_{max} - V_{min}$  and thus, for each sub-group, a mean standard deviation, associated with an x-axis value  $v = (B_i + B_s)/2$ , is obtained; and

the program of instructions embodied in a medium for causing the machine to provide for performing an operation of regression on the dots obtained at the previous

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step to determine the coefficients  $\alpha$ ,  $\beta$  and  $\gamma$  of the noise function:  $\sigma(v) = \alpha.\sqrt{v} + \beta.v + \gamma$   
defining the noise for a given value  $v$ .